What we claim as our invention is:

CLAIMS:

[c1] 1. An apparatus for applying data representing a watermark to data representing an image, the apparatus comprising: a source of location and time data;

an error coding unit connected to receive the location and time data for applying a forward error correction algorithm to the said location and time data and outputting error coded data therefrom;

a code spreading unit coupled to receive the error coded data for spreading the error coded data to create spread data by repeatedly outputting portions of the error coded data a number of times therefrom;

a DES code generator for generating and outputting data representing a DES code;

a combiner for combining the spread data and the DES code and outputting watermark data representing a location and time specific watermark;

a receiver for receiving signals containing said data representing an image as DCT coefficients in transform space, which data is received in an encoded and compressed form on a signal medium, and for receiving an apparatus specific key;

a decoding circuit responsive to the apparatus specific key for decoding and decompressing the received signals to recover the data representing an image therefrom;

a control circuit for analyzing at least a component of the image data to determine an attribute thereof and to output a signal representative of the attribute;

a marking control unit, coupled to receive the signal from the control circuit, the image data from the source and the watermark data from the combiner, for adding the watermark data to the image data depending on a characteristic of the attribute and a characteristic of the image data;

an inverse DCT transform circuit connected to receive the watermarked image data and to convert the same from data representing the image as DCT coefficients in transformation space to data representing the image in pixel space;

a pixel processor connected to receive the data representing the image in pixel space for converting the pixel data into a format suitable for display; and

a projector connected to receive formatted pixel data from the pixel processor for projecting the image represented thereby.

[c2] 2. An apparatus as claimed in claim 1, further comprising a source of program key data and a source of frame index data uniquely identifying each frame in a moving image, and wherein the DES code generator is connected to the source to receive the frame index data therefrom and to generate a DES code depending on the frame index data and the program key data.

[c3] 3. An apparatus as claimed in claim 1, further comprising a source of program key data and a source of frame index data uniquely identifying a predetermined number of frames in a moving image, and wherein the DES code generator is connected to the source to receive the frame index data therefrom and to generate a DES code depending on the frame index data and the program key data.

[c4] 4. An apparatus as claimed in claim 2, wherein the combiner comprises an exclusive-OR (XOR) gate for combining the spread data and the DES code on a bit-by-bit basis according to an XOR function.

[c5] 5. An apparatus as claimed in claim 4, wherein the control circuit is connected to receive data representing the luminance component of the image, and is configured to determine as said attribute an amplitude value of the luminance component as the $\log_2$ of the value of the luminance component.

[c6] 6. An apparatus as claimed in claim 5, wherein the marking control unit is arranged to generate as a generated value from the watermark data a positive or negative value and to add the generated value to the image data depending on the $\log_2$ of the value of the luminance component being greater than a predetermined threshold.

[c7] 7. An apparatus for applying data representing a watermark to data representing an image, the apparatus comprising:

means for supplying location and time data;

means for receiving the location and time data, for applying error coding to the said location and time data, and outputting error coded data therefrom;

spreading means coupled to receive the error coded data for applying a spreading function to the error coded data and outputting spread data therefrom;

means for generating and outputting data representing a pseudo-random code;

means for combining the spread data and the pseudo-random code and outputting watermark data representing a location and time specific watermark;

means for supplying image data representing an image in transformation space;

means for analyzing at least a component of the image data to determine an attribute thereof and for outputting a signal representative of the attribute; and

marking means, coupled to receive the signal representative of the attribute, the image data and the watermark data, for adding the watermark data to the image data depending on a characteristic of the attribute and a characteristic of the image data.

[c8] 8. An apparatus as claimed in claim 7, wherein the means for generating and outputting data representing a pseudo-random code is configured to apply a forward error correction algorithm to the location and time data.

[c9] 9. An apparatus as claimed in claim 7, wherein the spreading means is configured to apply the spreading function depending on a spreading factor.

[c10] 10. An apparatus as claimed in claim 7, wherein the spreading means is configured to apply a spreading function in which bits in the error coded data are repeated a number of times.

[c11] 11. An apparatus as claimed in claim 7, wherein the means for generating and outputting data representing a pseudo-random code comprises a DES engine.

[c12] 12. An apparatus as claimed in claim 11, further comprising means for supplying program key data and wherein the DES engine is connected to the means for supplying to receive the program key data therefrom and to generate a pseudo-random code depending on the program key data.

[c13] 13. An apparatus as claimed in claim 11, further comprising means for supplying frame index data uniquely identifying each frame in a moving image, and wherein the DES engine is connected to the means for supplying frame index data to receive the frame index data therefrom and to generate a pseudo-random code depending on the frame index data.

[c14] 14. An apparatus as claimed in claim 11, further comprising means for supplying frame index data uniquely identifying a predetermined number of frames in a moving image, and wherein the DES engine is connected to the means for supplying frame index data to receive the frame index data therefrom and to generate a pseudo-random code depending on the frame index data.

[c15] 15. An apparatus as claimed in claim 12, further comprising means for supplying frame index data uniquely identifying each frame in a moving image, and wherein the DES engine is connected to the means for supplying frame index data to receive the frame index data therefrom and to generate a pseudo-random code depending on the frame index data and the program key data.

[c16] 16. An apparatus as claimed in claim 7, wherein the combining means comprises an exclusive-OR (XOR) gate for combining the spread data and the pseudo-random code on a bit-by-bit basis according to an XOR function.

[c17] 17. An apparatus as claimed in claim 7, wherein the means for analyzing at least a component of the image data is connected to receive data representing the luminance component of the image.

[c18] 18. An apparatus as claimed in claim 7, wherein the means for analyzing at least a component of the image data is connected to receive data representing a chrominance component of the image.

[c19] 19. An apparatus as claimed in claim 7, wherein the means for analyzing at least a component of the image data is configured to determine an amplitude value as the attribute.

[c20] 20. An apparatus as claimed in claim 19, wherein the amplitude is determined as the $\log_2$ of a value of the component of the image data.

[c21] 21. An apparatus as claimed in claim 7, wherein the marking means is arranged to generate as a generated value from the watermark data a positive or negative value and to add the generated value to the image data depending on the said characteristic of the attribute.

[c22] 22. An apparatus as claimed in claim 21, wherein the means for analyzing at least a component of the image data is configured to determine an amplitude value as the attribute and the characteristic is the amplitude value being greater than a predetermined threshold.

[c23] 23. An apparatus as claimed in claim 22, wherein the amplitude is determined as the $\log_2$ of a value of the component of the image data.

[c24] 24. An apparatus as claimed in claim 7, further comprising:

means for receiving signals containing said data representing an image in an encoded and compressed form on a signal medium, and for receiving an apparatus specific key;

decoding means responsive to the apparatus specific key for decoding and decompressing the received signals to recover the data representing an image therefrom.

[c25] 25. An apparatus as claimed in claim 24, wherein the signals are conveyed on the medium as data packets and the means for receiving signals comprises data interface means for receiving the data packets.

[c26] 26. An apparatus as claimed in claim 24, wherein the means for receiving signals is arranged to receive the apparatus specific key through a medium different than the medium from which the encoded and compressed data signals are received.

[c27] 27. An apparatus as claimed in claim 24, wherein the signals are encoded using DES encryption and the decoding circuit comprises a DES decryption engine.

[c28] 28. An apparatus as claimed in claim 24, wherein the signals are compressed using a lossless compression technique.

[c29] 29. An apparatus as claimed in claim 28, wherein the lossless compression technique comprises run-length encoding.

[c30] 30. An apparatus as claimed in claim 24, wherein the signals are compressed using a lossy compression technique.

[c31] 31. An apparatus as claimed in claim 30, wherein the lossy compression technique comprises block quantization.

[c32] 32. An apparatus as claimed in claim 24, further comprising inverse transforming means circuit coupled to receive the watermarked image data and to convert the same from data representing the image in transformation space to data representing the image in pixel space.

[c33] 33. An apparatus as claimed in claim 32, further comprising pixel processing means coupled to receive the data representing the image in pixel space for converting the pixel data into a format suitable for display by a projector.

[c34] 34. An apparatus as claimed in claim 33, further comprising an interface means for buffering data from the inverse transforming means for the pixel processing means.

[c35] 35. An apparatus as claimed in claim 33, further comprising displaying means coupled to receive formatted pixel data from the pixel processor for displaying the image represented by the pixel data.

[c36] 36. A method of applying data representing a watermark to data representing an image, the method comprising:

supplying location and time data;

applying a forward error correction algorithm to the said location and time data to produce error coded data;

applying a spreading function to the error coded data to create spread data by repeating portions of the error coded data a number of times;

generating data representing a DES code;

combining the spread data and the DES code to create watermark data representing a location and time specific watermark;

receiving signals containing said data representing an image as DCT coefficients in transform space, which data is received in an encoded and compressed form on a signal medium;

receiving an apparatus specific key;

decoding and decompressing the received signals responsive to the apparatus specific key to recover the data representing an image therefrom;

analyzing at least a component of the image data to determine an attribute thereof and to create a signal representative of the attribute;

adding the watermark data to the image data depending on a characteristic of the attribute and a characteristic of the image data;

converting the watermarked image data from data representing the image as DCT coefficients in transformation space to data representing the image in pixel space;

converting the pixel data into a format suitable for display; and

projecting the image represented by the formatted pixel data.

[c37] 37. A method as claimed in claim 36, further comprising:

supplying program key data;

supplying frame index data uniquely identifying each frame in a moving image; and

generating the DES code depending on the frame index data and the program key data.

[c38] 38. A method as claimed in claim 36, further comprising:

supplying program key data;

supplying frame index data uniquely identifying a predetermined number of frames in a moving image; and

generating the DES code depending on the frame index data and the program key data.

[c39] 39. A method as claimed in claim 37, further comprising combining the spread data and the DES code on a bit-by-bit basis according to an XOR function.

[c40] 40. A method as claimed in claim 39, further comprising:

receiving data representing the luminance component of the image; and

determining as said attribute an amplitude value of the luminance component as the $\log_2$ of the value of the luminance component.

[c41] 41. A method as claimed in claim 40, further comprising:

generating as a generated value from the watermark data a positive or negative value; and

adding the generated value to the image data depending on the $\log_2$ of the value of the luminance component being greater than a predetermined threshold.

[c42] 42. A method of applying data representing a watermark to data representing an image, the method comprising:

supplying location and time data;

applying error coding to the said location and time data to produce error coded data;

applying a spreading function to the error coded data to produce spread data;

generating data representing a pseudo-random code;

combining the spread data and the pseudo-random code to produce watermark data representing a location and time specific watermark;

supplying image data representing an image in transformation space;

analyzing at least a component of the image data to determine an attribute thereof to produce a signal representative of the attribute; and

adding the watermark data to the image data depending on a characteristic of the attribute and a characteristic of the image data.

[c43] 43. A method as claimed in claim 42, further comprising applying a forward error correction algorithm to the location and time data.

[c44] 44. A method as claimed in claim 42, further comprising applying the spreading function depending on a spreading factor.

[c45] 45. A method as claimed in claim 42, further comprising applying a spreading function in which bits in the error coded data are repeated a number of times.

[c46] 46. A method as claimed in claim 45, wherein the pseudo-random code generator is generated by way of a DES engine.

[c47] 47. A method as claimed in claim 46, further comprising receiving program key data and generating a pseudo-random code depending on the program key data.

[c48] 48. A method as claimed in claim 46, further comprising:

supplying frame index data uniquely identifying each frame in a moving image; and

generating a pseudo-random code depending on the frame index data.

[c49] 49. A method as claimed in claim 46, further comprising:

supplying frame index data uniquely identifying a predetermined number of frames in a moving image; and

generating a pseudo-random code depending on the frame index data.

[c50] 50. A method as claimed in claim 47, further comprising:

supplying frame index data uniquely identifying each frame in a moving image, and

generating a pseudo-random code depending on the frame index data and the program key data.

[c51] 51. A method as claimed in claim 47, further comprising:

supplying frame index data uniquely identifying a predetermined number of frames in a moving image, and

generating a pseudo-random code depending on the frame index data and the program key data.

[c52] 52. A method as claimed in claim 42, further comprising combining the spread data and the pseudo-random code on a bit-by-bit basis according to an XOR function.

[c53] 53. A method as claimed in claim 42, further comprising supplying data representing the luminance component of the image.

[c54] 54. A method as claimed in claim 42, further comprising determining an amplitude value as the attribute of the image.

[c55] 55. A method as claimed in claim 54, wherein the amplitude is determined as the $\log_2$ of a value of the component of the image data.

[c56] 56. A method as claimed in claim 42, further comprising:

generating as a generated value from the watermark data a positive or negative value; and

adding the generated value to the image data depending on the said characteristic of the attribute.

[c57] 57. A method as claimed in claim 56, further comprising is determining an amplitude value as the attribute, and wherein the characteristic is the amplitude value being greater than a predetermined threshold.

[c58] 58. A method as claimed in claim 57, wherein the amplitude is determined as the log2 of a value of the component of the image data.

[c59] 59. A method as claimed in claim 42, further comprising:

receiving signals containing said data representing an image in an encoded and compressed form on a signal medium;

receiving an apparatus specific key; and

responding to the apparatus specific key by decoding and decompressing the received signals to recover the data representing an image therefrom.

[c60] 60. A method as claimed in claim 59, wherein the signals are conveyed on the medium as data packets.

[c61] 61. A method as claimed in claim 59, wherein the apparatus specific key is received via a medium different than the medium from which the encoded and compressed data signals are received.

[c62] 62. A method as claimed in claim 59, wherein the signals are encoded using DES encryption.

[c63] 63. A method as claimed in claim 59, wherein the signals are compressed using a lossless compression technique.

[c64] 64. A method as claimed in claim 63, wherein the lossless compression technique comprises run-length encoding.

[c65] 65. A method as claimed in claim 59, wherein the signals are compressed using a lossy compression technique.

[c66] 66. A method as claimed in claim 65, wherein the lossy compression technique comprises block quantization.

[c67] 67. A method as claimed in claim 59, further comprising converting the watermarked image data from data representing the image in transformation space to data representing the image in pixel space.

[c68] 68. A method as claimed in claim 67, further comprising converting the pixel data into a format suitable for display by a projector.

[c69] 69. A method as claimed in claim 68, further comprising displaying the image represented by the pixel data.

[c70] 70. An apparatus for adding a watermark to a moving image as it is displayed, the apparatus comprising:

a watermark generator in which data representing a watermark is generated containing first information pertaining to the displaying of the moving image and protected by forward error encoding and second information pertaining to the displaying of the moving image and protected by scrambling; and

a watermark applicator for applying the watermark data to image data representing substantially all of the moving image depending on a characteristic of the data.

[c71] 71. An apparatus as claimed in claim 70, wherein the watermark generator is connected to receive at least one of location data and time data as said first information pertaining to the displaying of the image.

[c72] 72. An apparatus as claimed in claim 70, wherein the watermark generator is connected to receive at least one of program data identifying the moving image and frame

data unique in identifying each frame of the moving image as said second information pertaining to the displaying of the image.

[c73] 73. An apparatus as claimed in claim 70, wherein the watermark generator is connected to receive at least one of program data identifying the moving image and frame data unique in identifying a predetermined number of frames of the moving image as said second information pertaining to the displaying of the image.

[c74] 74. An apparatus as claimed in claim 72, wherein the watermark generator is connected to receive at least one of location data and time data as said first information pertaining to the displaying of the image.

[c75] 75. An apparatus as claimed in claim 70, wherein the watermark generator comprises an error correcting circuit for receiving said first information pertaining to the displaying of the image and applying said forward error encoding.

[c76] 76. An apparatus as claimed in claim 70, wherein the watermark generator comprises a DES engine for receiving said second information pertaining to the displaying of the image and scrambling the same by generating a pseudo-random code depending on the second information.

[c77] 77. An apparatus as claimed in claim 70, wherein the watermark applicator comprises an amplitude control module for controlling application of the watermark data to the image data depending on the amplitude of the image data.

[c78] 78. An apparatus as claimed in claim 70, wherein the watermark applicator comprises an adder for adding the watermark data to the image data.

[c79] 79. A watermarking system for applying data representing a moving image to produce watermarked image data which is output to a display device for display of the

moving image represented thereby, in which system information identifying at least one of the system, the image and the displaying of the image is convolutionally encoded and spread and information identifying at least one of the system, the image and the displaying of the image is encrypted so as to produce the watermark data which is applied to substantially all data representing the moving image with the exception of data having a value below a determined level in order to minimize the introduction of visible noise and other artifacts into the image by the watermark.